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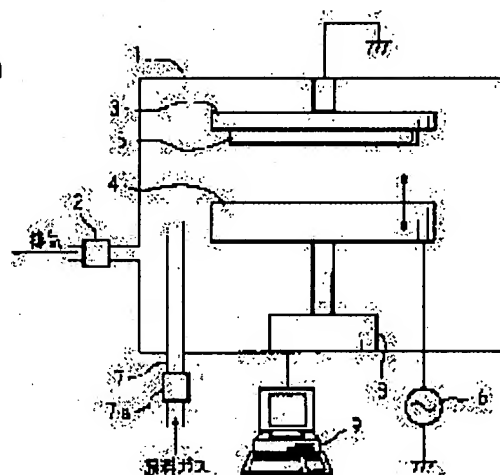
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(54) FILM-FORMING APPARATUS, PLASMA CVD APPARATUS, METHOD OF FORMING FILM, AND SPUTTERING APPARATUS

(57)Abstract:

PROBLEM TO BE SOLVED: To provide a film-forming apparatus having proper controllability, with which physical properties of the formed film can be easily controlled, and which can form a film with high productivity.

SOLUTION: A substrate 5 on which a film is to be formed is loaded on an anode electrode 3, and a source gas is fed to a reaction chamber 1; high-frequency voltage is applied between the anode electrode 3 and a cathode electrode 4, positioned facing the anode electrode 3 to generate plasma of the source gas; and the cathode electrode 4 is moved close to or moved away from the anode electrode 3, during the film formation by controlling a driving section 8, using a control section 9.



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DETAILED DESCRIPTION

Detailed Description of the Invention]

[0001]

Field of the Invention] This invention relates to membrane formation equipment, plasma-CVD equipment, the membrane formation approach, and a sputtering system.

[0002]

Description of the Prior Art] The chemical vapor deposition (CVD) using the plasma is used when forming the semi-conductor layer of a photovoltaic cell. Drawing 6 is the mimetic diagram of conventional plasma-CVD equipment. One drawing has carried out opposite arrangement of the anode electrode 3 which is a reaction chamber and should lay a substrate 5 in the reaction chamber 1 interior of this, and the cathode electrode 4 connected to RF generator 6 of the reaction chamber 1 exterior. Moreover, the reaction chamber 1 was equipped with the exhaust air system 2 which exhausts the reaction chamber 1 interior of this in the shape of a vacuum, and the supply pipe 7 which supplies material gas from this reaction chamber 1 exterior, and this supply pipe 7 is equipped with control-of-flow system 7a which controls the flow rate of material gas. An actuator 8 moves the cathode electrode 4 in the attachment-and-detachment direction over the anode electrode 3.

[0003] When the silicon germanium film is formed in the substrate 5 laid in the anode electrode 3 using said plasma-CVD equipment, Exhaust the reaction chamber 1 interior using the exhaust air system 2, and the inter-electrode distance between the anode electrode 3 and the cathode electrode 4 is suitably separated using an actuator 8. A silane and germane are supplied in a reaction chamber 1 as material gas of silicon germanium using a supply pipe 7. By impressing high-frequency voltage between counterelectrodes using RF generator 6, plasma decomposition of a silane and the germane is carried out, a silicon precursor and a germanium precursor, nothing and this silicon precursor, and a germanium precursor are vapor-deposited to a substrate 5, and silicon germanium is deposited. When changing continuously the presentation ratio of the direction of thickness of this silicon germanium, the flow rate of material gas is controlled using control-of-flow system 7a, and a presentation ratio is changed.

[0004] It is known that a photovoltaic cell can improve photoelectrical effectiveness by changing continuously the presentation ratio of the direction of thickness of a semi-conductor layer (JP,10-214984,A).

[0005] At the time of manufacture of electron devices (LED, TFT, EL, etc.), not only the semi-conductor film but various kinds of film (an insulator layer, electric conduction film) is formed. In this membrane formation, the membrane formation approach by the sputtering system and the sputtering system is used besides the membrane formation approach by plasma-CVD equipment and plasma-CVD equipment. In the conventional sputtering system, it is necessary to embrace the class of film to form, to change and exchange targets each time from what the physical properties (the classification of a conductor, a semi-conductor, and an insulator, a presentation, a presentation ratio, a conduction type, conductivity, etc.) of the film fundamentally formed according to the class of target are decided for, and to pick out the substrate with which the film is formed from a sputtering system. Moreover, to use a special target, it is necessary to also make a sputtering system only into for the targets from a viewpoint of contamination (foreign matter mixing) prevention etc. Thus, when forming the film of different physical properties, since the conventional sputtering system needed to pick out the device under manufacture from that modification of a target is needed and a sputtering system, it had brought about the increment in the number of manufacture processes, protraction of a throughput, and lowering of the product yield, i.e., the increment in a manufacturing cost.

[0006] Moreover, in the conventional spatter, a spatter is carried out in the gas ambient atmosphere containing V group atom which serves as an acceptor, using the target which added the impurity containing V group atom which serves as an acceptor as an approach of controlling an II-VI group semi-conductor thin film to p mold conductivity, for example, and here is the approach of controlling to p mold conductivity by incorporating an acceptor in the film to form. Moreover, a

patter is carried out in the gas ambient atmosphere containing the III group atom which serves as a donor, using the target which added the impurity containing the III group atom which serves as a donor as an approach of controlling an I-VI group semi-conductor thin film to n mold conductivity similarly, and there is the approach of controlling to n mold conductivity by incorporating a donor in the film to form.

[0007] That is, it is required to carry out a sputter in the gas ambient atmosphere containing the atom which prepares respectively the target which added the impurity containing the atom which serves as an acceptor or a donor, and performs a sputter, or serves as an acceptor or a donor, in order to carry out valence-electron control (pn control) of the semi-conductor thin film formed by the sputter. Furthermore, in order to carry out the laminating of the semi-conductor thin film controlled by these p molds and n mold and to form pn junction, it is required to make a p type semiconductor thin film and a n-type-semiconductor thin film into a respectively different target and different process conditions (a different sputtering system), and it is difficult to form membranes continuously within the same sputtering system. Therefore, when carrying out valence-electron control by the conventional sputter approach, it is necessary to prepare two or more target or two or more sputtering gas, a process increases, and a throughput becomes late, as a result a manufacturing cost becomes high.

[0008] Moreover, in the conventional sputter, when forming the film by the sputter (reactant sputter) into the gas containing reactant gas, in order to control the concentration in the film of the element contained in reactant gas, it is necessary to control the flow rate (partial-pressure-of-gas ratio) of reactant gas and sputtering gas. However, since the control by the quantity-of-gas-flow ratio has a time lag in the flow of gas, as for a reaction, it is blunt to require time amount to reflect control of the quantity-of-gas-flow ratio in a control system in the condition of the gas of a reaction chamber etc., and quick control cannot be performed and needs control by the complicated control-of-flow system.

[0009] Moreover, the conventional sputtering system lacks in mass production nature from the particulars on structure, and continuous membrane formation was not able to do it.

[0010]

[Problem(s) to be Solved by the Invention] When controlling the flow rate of material gas and changing a presentation ratio using conventional plasma-CVD equipment, in order for exchange of material gas to take time amount, Time difference arises between the event of changing the flow rate of material gas to a necessary value, and the event of the abundance ratio of the material gas in a reaction chamber 1 becoming a necessary value, and it cannot control promptly. This sake, When especially the rate of sedimentation of a film ingredient was early, there was a problem that it became difficult to change the presentation ratio of a film ingredient to a precision. Moreover, the problem of being required also had complicated control-of-flow system 7a designed in consideration of the detailed flow of material gas.

[0011] When forming the film of different physical properties (the classification of a conductor, a semi-conductor, and an insulator, a presentation, a presentation ratio, a conduction type, conductivity, etc.), since modification of a target was needed, the conventional sputtering system once needed to pick out the device under membrane formation from the sputtering system, and had problems, such as bringing about the increment in the number of manufacture processes, retraction of a throughput, and lowering of the product yield, i.e., the increment in a manufacturing cost. Moreover,

when valence-electron control was carried out by the conventional sputter approach, there was a problem that it is necessary to prepare two or more target or two or more sputtering gas, a process increased, and a throughput became late, as a result a manufacturing cost became high. Moreover, the conventional sputtering system which controls a quantity-of-gas-flow ratio had the blunt reaction, and quick control was not completed and had the problem of needing control by the complicated control-of-flow system.

[0012] It is in this invention being made in view of this situation, and the place made into the object being able to control easily the physical properties of the film formed by considering as the configuration which carries out adjustable control of the distance between the part of the 1st electrode and the 2nd electrode which should arrange the substrate which forms the film, and offering the good membrane-formation equipment of the controllability with sufficient productivity which can form membranous.

[0013] By having a means to change the inter-electrode distance between the 1st electrode and the 2nd electrode, other objects of this invention do not have to carry out complicated control by the control-of-flow means (without having a complicated control means), and aim to let manufacture offer easy plasma-CVD equipment. By having the 2nd electrode which has two or more slant faces which incline in the migration direction of the 1st electrode or the 2nd electrode, other objects of this invention do not have to carry out complicated control by the control-of-flow means (without having a complicated control means), and offering easy plasma-CVD equipment has manufacture.

[0014] other objects of this invention make the 1st electrode which arranges the substrate approach or isolate the 2nd electrode -- for example, it is in offering the membrane formation approach that the presentation ratio of a film ingredient can be changed to a precision, without changing other formation conditions, such as a flow rate of material gas, or

discharge conditions, using plasma-CVD equipment according to claim 2. Other objects of this invention are, for example using plasma-CVD equipment according to claim 3 by using the 2nd electrode which has two or more slant faces which incline in the migration direction of the 1st electrode or the 2nd electrode to offer the membrane formation approach according to claim 4 and the membrane formation approach that the same effectiveness can be acquired.

[0015] Moreover, other objects of this invention are by having a means to change the inter-electrode distance between the 1st electrode and the 2nd electrode to offer the membrane formation approach by the single sputtering system, the single target, the sputtering system that can form continuously in arbitration the film of physical properties (the classification of a conductor, a semi-conductor, and an insulator, a presentation, a presentation ratio, a conduction type, conductivity, etc.) which are different in a single process, and this sputtering system. For example, when an oxide ingredient is used for a target, it aims at offering the sputtering system which can make a membranous class continuously with a conductor, a semi-conductor, and an insulator, and can divide it, and the membrane formation approach.

[0016] Moreover, other objects of this invention are by having the 2nd electrode which has two or more slant faces which incline in the migration direction of the 1st electrode or the 2nd electrode to offer the membrane formation approach by the single sputtering system, the single target, the sputtering system that can form continuously in arbitration the film of physical properties (the classification of a conductor, a semi-conductor, and an insulator, a presentation, a presentation ratio, a conduction type, conductivity, etc.) which are different in a single process, and this sputtering system. For example, when an oxide ingredient is used for a target, it aims at offering the sputtering system which can make a membranous class continuously with a conductor, a semi-conductor, and an insulator, and can divide it, and the membrane formation approach.

[0017] Moreover, other objects of this invention are by having the 2nd electrode which has two or more partial electrodes with which the distance between the 1st electrode differs to offer the membrane formation approach by the single sputtering system, the single target, the sputtering system that can form continuously in arbitration the film of physical properties (the classification of a conductor, a semi-conductor, and an insulator, a presentation, a presentation ratio, a conduction type, conductivity, etc.) which are different in a single process, and this sputtering system. For example, when an oxide ingredient is used for a target, it aims at offering the sputtering system which can make a membranous class continuously with a conductor, a semi-conductor, and an insulator, and can divide it, and the membrane formation approach.

[0018] Moreover, for example, in formation of the compound system thin film containing two or more elements, an alloy system thin film, etc., it aims at offering the membrane formation approach by the sputtering system which can control a presentation ratio to a precision, and this sputtering system. Moreover, it aims at offering the membrane formation approach by the sputtering system which can control a presentation ratio to a precision, and this sputtering system in formation of the metallic-oxide thin film containing the element which has the property which serves as a gas among base, for example, a nitride thin film, etc. Moreover, it faces, forming an II-VI group semi-conductor thin film for example, and aims at offering the membrane formation approach by the sputtering system which can make an II-VI group semi-conductor thin film with p mold and n mold at the time of formation, and can divide a membranous class, and this sputtering system by controlling inter-electrode distance by forming the film by which valence-electron control is carried out in the direction of thickness. Moreover, it aims at offering the membrane formation approach by the sputtering system which can control the concentration in the film of the element contained in reactant gas, for example, and this sputtering system. Moreover, it aims at offering the membrane formation approach by the sputtering system which fitted mass production especially, and this sputtering system suitable for mass production.

[0019] [Means for Solving the Problem] The 1st electrode which arranges the substrate with which the membrane formation equipment concerning the 1st invention should form the film in a reaction chamber, In membrane formation equipment equipped with the 2nd electrode which counters the part which should arrange said substrate of this 1st electrode, and is arranged, and a means to supply gas in said reaction chamber, it is characterized by having considered as the configuration which carries out adjustable control of the distance between the part and the 2nd electrode which should arrange said substrate.

[0020] In the 1st invention, since it considered as the configuration which carries out adjustable control of the distance between the part and the 2nd electrode which should arrange a substrate, it becomes possible to be able to control the physical properties of the film to form easily, and to offer the good membrane formation equipment of the controllability with sufficient productivity which can form membranous.

[0021] The 1st electrode which arranges the substrate with which the plasma-CVD equipment concerning the 2nd invention should form the film in a reaction chamber, The 2nd electrode which counters the part which should arrange said substrate of this 1st electrode, and is arranged, With the actuator which moves at least one side in the attachment-

and-detachment direction over another side among this 2nd electrode or said 1st electrode In plasma-CVD equipment equipped with a means to supply material gas in said reaction chamber, and a means to impress an electrical potential difference in order to generate the plasma of said material gas between said 1st electrode and said 2nd electrode It is characterized by having a means to memorize the modification data of the inter-electrode distance between said 1st electrode and said 2nd electrode, and a means to control said actuator according to these modification data.

[0022] The 1st electrode which should arrange a substrate when manufacturing the plasma-CVD equipment for forming the film to which the presentation ratio of the direction of thickness was changed continuously, if it is in the 2nd invention, To conventional plasma-CVD equipment equipped with the actuator which adjusts the inter-electrode distance between the 2nd electrode Since it is not necessary to suppose that a means to control said actuator is added so that the inter-electrode distance between the 1st electrode and the 2nd electrode may be changed according to the modification data of inter-electrode distance, and it is not necessary to design this means in consideration of the detailed flow of material gas, It is not necessary to carry out complicated control by the control-of-flow means (without having a complicated control means), and manufacture can offer the good plasma-CVD equipment of a controllability easily.

[0023] The 1st electrode which arranges the substrate with which the plasma-CVD equipment concerning the 3rd invention should form the film in a reaction chamber, The 2nd electrode which counters the part which should arrange said substrate of this 1st electrode, and is arranged, With the actuator which moves at least one side in the direction which crosses in the opposite direction of said 1st electrode and said 2nd electrode among this 2nd electrode or said 1st electrode In plasma-CVD equipment equipped with a means to supply material gas in said reaction chamber, and a means to impress an electrical potential difference in order to generate the plasma of said material gas between said 1st electrode and said 2nd electrode Said 2nd electrode has two or more slant faces in the side which counters said 1st electrode of this 2nd electrode, and it is characterized by this slant face inclining in the migration direction of said 1st electrode or said 2nd electrode.

[0024] When the plasma-CVD equipment for forming the film to which the presentation ratio of the direction of thickness was changed continuously if it is in the 3rd invention is manufactured, At least one side moves among the 1st electrode which should arrange a substrate, or the 2nd electrode. To therefore, difficult conventional plasma-CVD equipment, controlling the flow rate of material gas and changing a presentation ratio In order to have the 2nd electrode which has two or more slant faces which replace with the 2nd conventional plate-like electrode, and incline in the migration direction of the 1st electrode or the 2nd electrode in the side which counters said 1st electrode, It is not necessary to carry out complicated control by the control-of-flow means (without having a complicated control means), and manufacture can offer the good plasma-CVD equipment of a controllability easily.

[0025] The membrane formation approach concerning the 4th invention arranges the substrate which should form the film in the 1st electrode which it had in the reaction chamber, and supplies two or more kinds of material gas in said reaction chamber. Said 1st electrode, An electrical potential difference is impressed between the 2nd electrode which counters said substrate and is arranged, the plasma of said material gas is generated, and it is characterized by moving at least one side in the attachment-and-detachment direction over another side among said 2nd electrode or said 1st electrode during membrane formation.

[0026] If it is in the 4th invention, the substrate which should form the film is arranged to the 1st electrode, the material gas (a silane and germane) of the film ingredient (for example, silicon germanium) which comes to use two or more matter is supplied all over a reaction chamber, and an electrical potential difference is impressed between the 1st electrode and the 2nd electrode. At this time, material gas carries out plasma decomposition, said matter serves as a precursor (a silicon precursor and germanium precursor), respectively, and when this precursor vapor-deposits to a substrate, the film (silicon germanium film) is formed in a substrate. The presentation ratio of the film ingredient deposited on the substrate is proportional to the ratio of concentration of the precursor with which this substrate touched. Concentration becomes low as the precursor with a small diffusion rate has the high concentration in a gaseous phase and separates from this 2nd electrode near the 2nd electrode compared with a precursor with a large diffusion rate. For this reason, inter-electrode distance between the 1st electrode and the 2nd electrode is made small during membrane formation, and the presentation ratio of a film ingredient can be changed to a precision, without changing other formation conditions, such as a flow rate of material gas, or discharge conditions, using the plasma-CVD equipment of the 1st invention, since a diffusion rate can increase the amount of vacuum evaporation of a small precursor, can enlarge said inter-electrode distance and can decrease said amount of vacuum evaporation.

[0027] Moreover, since said concentration falls more rapidly and regularly as it comes to carry out localization of the plasma to the 2nd electrode side extremely and separates from this 2nd electrode the more, the more the pressure in a reaction chamber is high, when the plasma is being generated in a reaction chamber, the presentation ratio of a film ingredient can be changed more to a precision. Moreover, near the 2nd electrode, since the concentration of a precursor

With a small diffusion rate becomes high, the ratio of concentration of a precursor becomes larger than the flow rate of material gas, the alimentation of a film ingredient with the small diffusion rate of a precursor increases, and the utilization effectiveness of this film ingredient improves.

[0028] The membrane formation approach concerning the 5th invention arranges the substrate which should form the film in the 1st electrode which it had in the reaction chamber, and supplies two or more kinds of material gas in said reaction chamber. Said 1st electrode, Counter said substrate, arrange, impress an electrical potential difference between the 2nd electrode which has two or more slant faces in the side which counters this substrate, and the plasma of said material gas is generated. It is characterized by moving at least one side in the direction which crosses in the opposite direction of said 1st electrode and said 2nd electrode among said 2nd electrode or said 1st electrode during membrane formation.

[0029] If it is in the 5th invention, the substrate which should form the film is arranged to the 1st electrode, the material gas of the film ingredient which comes to use two or more matter is supplied all over a reaction chamber, an electrical potential difference is impressed between said 1st electrode and the 2nd electrode which has two or more slant faces, and, subsequently to the direction of a flat surface of the 1st electrode, at least one side is moved to it among the 1st electrode or the 2nd electrode. At this time, material gas carries out plasma decomposition, said matter serves as a precursor, respectively, and concentration becomes low as concentration is high and it separates from this 2nd electrode near the 2nd electrode compared with a precursor with a large diffusion rate, and a layer with this equal concentration produces the precursor with a small diffusion rate along said slant face of the 2nd electrode. For this reason, the 1st electrode will pass in order two or more layers from which the concentration of each precursor differs, respectively. Since pass a layer with the high concentration of said precursor, the amount of vacuum evaporatio of this precursor increases, a layer with said concentration low when inter-electrode distance is large is passed and said amount of vacuum evaporatio decreases, when the inter-electrode distance between this 1st electrode and the 2nd electrode is small, For example, the same effectiveness as the membrane formation approach of the 4th invention can be acquired using the plasma-CVD equipment of the 3rd invention.

[0030] The 1st electrode which arranges the substrate with which the sputtering system concerning the 6th invention should form the film in a reaction chamber, With the actuator which moves at least one side in the attachment-and-detachment direction over another side among the 2nd electrode which counters said substrate and arranges a target, and this 2nd electrode or said 1st electrode In a sputtering system equipped with a means to supply discharge gas in said reaction chamber, and a means to impress an electrical potential difference in order to generate the spatter by said discharge gas between said 1st electrode and said 2nd electrode It is characterized by having a means to memorize the modification data of the inter-electrode distance between said 1st electrode and said 2nd electrode, and a means to control said actuator according to these modification data.

[0031] The 1st electrode which arranges the substrate with which the sputtering system concerning the 7th invention should form the film in a reaction chamber, With the actuator which moves at least one side in the direction which crosses in the opposite direction of said 1st electrode and said 2nd electrode among the 2nd electrode which should counter said substrate and should arrange a target, and this 2nd electrode or said 1st electrode In a sputtering system equipped with a means to supply discharge gas in said reaction chamber, and a means to impress an electrical potential difference in order to generate the spatter by said discharge gas between said 1st electrode and said 2nd electrode Said 2nd electrode has two or more slant faces in the side which counters said 1st electrode, and this slant face is characterized by inclining in the migration direction of said 1st electrode or said 2nd electrode.

[0032] The 1st electrode which arranges the substrate with which the sputtering system concerning the 8th invention should form the film in a reaction chamber, With the actuator which moves at least one side in the direction which crosses in the opposite direction of said 1st electrode and said 2nd electrode among the 2nd electrode which should counter said substrate and should arrange a target, and this 2nd electrode or said 1st electrode In a sputtering system equipped with a means to supply discharge gas in said reaction chamber, and a means to impress an electrical potential difference in order to generate the spatter by said discharge gas between said 1st electrode and said 2nd electrode Said 2nd electrode is characterized by having two or more partial electrodes with which the distance between said 1st electrode differs.

[0033] The membrane formation approach concerning the 9th invention arranges the substrate which should form the film in the 1st electrode which it had in the reaction chamber. Counter the 2nd electrode at said substrate, arrange a target, and discharge gas is supplied in said reaction chamber. An electrical potential difference is impressed between said 1st electrode and said 2nd electrode, the spatter by said discharge gas is generated, and it is characterized by moving at least one side in the attachment-and-detachment direction over another side among said 2nd electrode or said 1st electrode during membrane formation.

[0034] The membrane formation approach concerning the 10th invention arranges the substrate which should form the film in the 1st electrode which it had in the reaction chamber. Counter the 2nd electrode which has two or more slant faces in the side which counters said substrate at said substrate, and a target is arranged. Supply discharge gas in said reaction chamber, impress an electrical potential difference between said 1st electrode and 2nd electrode, and the spatter by said discharge gas is generated. It is characterized by moving at least one side in the direction which crosses in the opposite direction of said 1st electrode and said 2nd electrode among said 2nd electrode or said 1st electrode during membrane formation.

[0035] The membrane formation approach concerning the 11th invention arranges the substrate which should form the film in the 1st electrode which it had in the reaction chamber. Counter the 2nd electrode equipped with two or more partial electrodes with which the distance between said 1st electrode differs at said substrate, and a target is arranged. Supply discharge gas in said reaction chamber, impress an electrical potential difference between said 1st electrode and said 2nd electrode, and the spatter by said discharge gas is generated. It is characterized by moving at least one side in the direction which crosses in the opposite direction of said 1st electrode and said 2nd electrode among said 2nd electrode or said 1st electrode during membrane formation.

[0036] Since it has a means to change the inter-electrode distance between the 1st electrode and the 2nd electrode, in the 5th invention and the 9th invention physical properties (a conductor --) which are different in a single sputtering system, a single target, and a single process The sputtering system which can form continuously film, such as classification of a semi-conductor and an insulator, a presentation, a presentation ratio, a conduction type, and conductivity, in arbitration, And when the membrane formation approach by this sputtering system can be offered, for example, an oxide ingredient is used for a target, the sputtering system which can make a membranous class continuously with a conductor, a semi-conductor, and an insulator, and can divide it, and the membrane formation approach can be offered.

[0037] Since it has the 2nd electrode which has two or more slant faces which incline in the migration direction of the 1st electrode or the 2nd electrode in the 7th invention and the 10th invention physical properties (a conductor --) which are different in a single sputtering system, a single target, and a single process The sputtering system excellent in the mass production nature which can form continuously film, such as classification of a semi-conductor and an insulator, a presentation, a presentation ratio, a conduction type, and conductivity, in arbitration, And when the membrane formation approach by this sputtering system can be offered, for example, an oxide ingredient is used for a target, the sputtering system which can make a membranous class continuously with a conductor, a semi-conductor, and an insulator, and can divide it, and the membrane formation approach can be offered.

[0038] Since it has the 2nd electrode which has two or more partial electrodes with which the distance between the 1st electrode differs in the 8th invention and the 11th invention physical properties (a conductor --) which are different in a single sputtering system, a single target, and a single process The sputtering system excellent in the mass production nature which can form continuously film, such as classification of a semi-conductor and an insulator, a presentation, a presentation ratio, a conduction type, and conductivity, in arbitration, When the membrane formation approach by this sputtering system can be offered, for example, an oxide ingredient is used for a target, the sputtering system and the membrane formation approach of making a membranous class continuously with a conductor, a semi-conductor, and an insulator, and dividing it can be offered.

[0039] In the 6th invention thru/or the 11th invention, the membrane formation approach by the sputtering system and this sputtering system which can control a presentation ratio to a precision can be offered in formation of the metallic-oxide thin film containing the element which has the property which serves as a gas among base, for example, a nitride thin film, etc. Moreover, it faces, forming an II-VI group semi-conductor thin film for example, and the membrane formation approach by the sputtering system and this sputtering system which can make an II-VI group semi-conductor thin film with p mold and n mold at the time of formation, and can divide a membranous class can be offered by controlling inter-electrode distance by forming the film by which valence-electron control was carried out in the direction of thickness. Moreover, the membrane formation approach by the sputtering system and spatter which can control the concentration in the film of the element contained in reactant gas, for example can be offered.

[0040]

[Embodiment of the Invention] Hereafter, this invention is explained in full detail based on the drawing in which the gestalt of the operation is shown.

<Gestalt 1 of operation> drawing 1 is the mimetic diagram of the plasma-CVD equipment concerning the gestalt 1 of operation of this invention. One in drawing is a reaction chamber which has carried out evacuation of the interior using the exhaust air system 2. Into the reaction chamber 1, opposite arrangement of the anode electrode 3 and the cathode electrode 4 of a plane [opposed face] is carried out, respectively. The anode electrode 3 is grounded and the cathode electrode 4 is connected to RF generator 6 of the reaction chamber 1 exterior. The glass substrate 5 which should form

membranes is laid in the opposed face side with the cathode electrode 4 of the anode electrode 3. the area of a substrate 5 is 225cm² it is -- it is smaller than the area of the opposed face of the cathode electrode 4. Moreover, the reaction chamber 1 is equipped with the supply pipe 7 and control-of-flow system 7a which supply material gas from this reaction chamber 1 exterior.

[0041] An actuator 8 moves the cathode electrode 4 in the attachment-and-detachment direction over the anode electrode 3 by having the stanchion which supports the cathode electrode 4, being controlled by the control section 9 of the reaction chamber 1 exterior, and driving this stanchion linearly in the direction of axial length of this stanchion. A control section 9 receives the entry of data of modification of the inter-electrode distance between the anode electrode 3 and the cathode electrode 4 coming from a personal computer to use, and according to the data which memorized and memorized these data, as the cathode electrode 4 does not contact the substrate 5 on the anode electrode 3, it controls an actuator 8. Said data are data of inter-electrode distance when the time amount and this time amount from membrane-formation initiation pass, investigate beforehand time amount required since the film which has the inter-electrode distance between the anode electrode 3 and the cathode electrode 4, and the relation and this presentation ratio of a film ingredient with a presentation ratio when forming membranes in this inter-electrode distance under necessary membrane formation conditions is formed on a substrate 5, and have decided on it.

[0042] The design of equipment is easy for the above plasma-CVD equipments in order not to have the need of being able to design, without taking the detailed flow of material gas into consideration, and performing precise control of a quantity-of-gas-flow ratio in control-of-flow system 7a. In addition, said plasma-CVD equipment may be a configuration which supplies material gas through a cathode electrode, for example, as long as inter-electrode distance is the configuration which can be changed into arbitration.

[0043] Next, the membrane formation approach when forming membranes using said plasma-CVD equipment is explained. A table 1 shows the membrane formation conditions when forming the silicon germanium film using said plasma-CVD equipment.

[0044]

[A table 1]

表 1

電極間距離 (cm)	0.8~4
基板温度 (℃)	200
圧力 (Pa)	100
RF パワー (mW/cm ²)	50
シラン流量 (sccm)	10
ゲルマン流量 (sccm)	1
水素流量 (sccm)	100

[0045] When forming the silicon germanium film from which the presentation ratio of the direction of thickness changes continuously using said plasma-CVD equipment, first, inter-electrode distance between the anode electrode 3 and the cathode electrode 4 is set to 4cm or more, a substrate 5 is laid in the opposed face of the anode electrode 3, and, subsequently the material gas (a silane and germane) of silicon germanium is supplied all over a reaction chamber 1 using a supply pipe 7. Next, high-frequency voltage is impressed between the anode electrode 3 and the cathode electrode 4 using RF generator 6, and the plasma of material gas is generated between the anode electrode 3 and the cathode electrode 4. The silane and germane who did plasma decomposition at this time become a silicon precursor and a germanium precursor. When a pressure is set to 100Pa or more, the plasma of high density carries out localization to a field with a thickness of less than 1.5cm along with the opposed face of the cathode electrode 4, and consists sheet-like of other parts.

[0046] In said field, the rate of a germanium precursor to a silicon precursor becomes larger than germane's rate to a silane, and the rate of a germanium precursor decreases in proportion to the inter-electrode distance from this field. Since the silicon germanium film is formed when each precursor vapor-deposits to a substrate 5, A control section 9 controls an actuator 8, said inter-electrode distance is first set to 4cm, membrane formation is started, next the cathode electrode 4 is gradually moved until this inter-electrode distance is set to 0.8cm. Subsequently The cathode electrode 4 is moved rapidly, said inter-electrode distance is set to 1.5cm, and this inter-electrode distance is held between proper time amount. Subsequently The cathode electrode 4 is moved rapidly, said inter-electrode distance is set to 0.8cm, finally, the cathode electrode 4 is moved gradually and membrane formation is ended until said inter-electrode distance is set to

1cm.

[0047] A table 2 shows the membrane formation conditions when forming the silicon germanium film from which the presentation ratio of the direction of thickness changes continuously using conventional plasma-CVD equipment.

[0048]

[A table 2]

表 2

電極間距離 (cm)	3
基板温度 (℃)	200
圧力 (Pa)	100
RFパワー (mW/cm ²)	50
シラン流量 (sccm)	10
ゲルマン流量 (sccm)	0~1.6
水素流量 (sccm)	100

[0049] Although a germane flow rate is made regularly (1sccm) and inter-electrode distance is changed between 0.8-4 cm) when using the CVD system of the gestalt of this operation, when using conventional plasma-CVD equipment, inter-electrode distance is made regularly (3cm), and a germane flow rate is changed between 0-1.6 (sccm).

[0050] Drawing 2 is a graph which shows the relation between the inter-electrode distance when forming membranes using the plasma-CVD equipment concerning the gestalt 1 of operation of this invention, and a presentation ratio. This graph shows distribution of the direction of thickness (A) of the presentation ratio (germanium/silicon (%)) of the silicon germanium in the film measured using the secondary ion measuring device (SIMS), and the inter-electrode distance at the time of this thickness location formation (cm). Drawing 3 is a graph which shows the relation between the flow rate when forming membranes using conventional plasma-CVD equipment, and a presentation ratio. This graph indicates the germane / silane flow rate at the time of this thickness location formation (%) to be distribution of the direction of thickness (A) of the presentation ratio (germanium/silicon (%)) of the silicon germanium in the film measured using SIMS.

[0051] When a presentation ratio is controlled using inter-electrode distance, the presentation ratio is changing to modification of inter-electrode distance and abbreviation coincidence and inter-electrode distance is rapidly changed from drawing 2, it turns out that a presentation ratio also changes rapidly. When a presentation ratio is controlled using a flow rate, it is late for modification of flow rate for a while, and the presentation ratio is changing and a flow rate is rapidly changed from drawing 3, it turns out that a presentation ratio changes gently. Although change of a presentation ratio is also more slow and becomes loose since change of the abundance ratio of the material gas in a reaction chamber becomes slow compared with change of flow rate when a presentation ratio is controlled using a flow rate, and large-sized plasma-CVD equipment is used especially When a presentation ratio is controlled using inter-electrode distance, even if it is a time of using large-sized plasma-CVD equipment, it follows in footsteps of change of inter-electrode distance, and a presentation ratio also changes.

[0052] Moreover, when inter-electrode distance is 1.5cm or less, presentation ratio = germanium / silane is 40% or more, and a membrane formation rate is 1.5A/s or more. At this time, it becomes utilization effectiveness = {presentation ratio x atom consistency (cm-3) x membrane formation rate (cm/min) x substrate area (cm²)} / more than {(Avogadro's number/22.4 (l)) x germane flow rate (l/min)} = 15%. [of material gas] The above membrane formation approaches can change the presentation ratio of a film ingredient to a precision, without changing other formation conditions, such as a flow rate of material gas, or discharge conditions, by changing an inter-electrode distance easily controllable by moving the cathode electrode 4.

[0053] Drawing 4 is the typical sectional view of the photovoltaic cell which has the pin structure manufactured using the plasma-CVD equipment concerning the gestalt 1 of operation of this invention. This photovoltaic cell comes to carry out the laminating of p amorphous layers, i layers, and the n layers, and a table 3 shows the formation conditions of p layers and n layers.

[0054]

[A table 3]

表 3

	p層形成条件	n層形成条件
基板温度 (℃)	150	200
圧力 (Pa)	13	13
RFパワー (mW/cm ²)	70	70
SiH ₄ 流量 (sccm)	10	10
H ₂ 流量 (sccm)	30	10
CH ₄ 流量 (sccm)	15	
B ₂ H ₆ 流量 (sccm)	0.1	
PH ₃ 流量 (sccm)		0.1

0055] Said photovoltaic cell is SnO₂ on the glass light transmission substrate 50. The translucency electrode layer 51 which uses and has the shape of concavo-convex surface type is formed. On this translucency electrode layer 51, use the conventional plasma-CVD method and 52 [p-layer] is formed. On this p layer 52, use said membrane formation approach and i layer 53 from which the presentation ratio of the direction of thickness changes continuously by controlling inter-electrode distance is formed. On this i layer 53, said plasma-CVD method is used, 54 [n-layer] is formed, and it comes to form the metal-electrode film 55 which used silver on this n layer 54 using a spatter.

0056] A table 4 shows the property (after [an optical exposure] property) after the presentation ratio of the direction of thickness irradiates light on the property (initial property) immediately after manufacture with the conventional photovoltaic cell (conventional example) which comes to form i layers which change continuously and AM-1.5, 100 nW/cm², 25 degrees C, and the conditions of 500 hours by controlling said photovoltaic cell (this example) and the flow rate of material gas.

0057]

A table 4]

表 4

	開放電圧 (V)	短絡電流 mA/cm ²	曲線因子	変換効率 (%)
本実施例 (初期特性)	.670	20.0	.730	9.78
本実施例 (光照射後特性)	.660	19.6	.690	8.90
従来例 (初期特性)	.650	19.9	.700	9.05
従来例 (光照射後特性)	.640	19.3	.650	8.03

0058] A table shows that open circuit voltage, the short-circuit current, the curvilinear factor, and the value of conversion efficiency show the high numeric value compared with the photovoltaic cell of the conventional example, respectively, and photoelectrical effectiveness of the photovoltaic cell of this example is improving. In addition, p layers, i layers, and n layers may be not only an amorphous substance but crystalline substances. Moreover, this invention may be used for p layers or n layers, and a presentation ratio may be changed. Moreover, an electrode layer, n layers, i layers, p layers, and a translucency electrode layer may be formed on the substrate of protection-from-light nature. Furthermore, the same effectiveness can be acquired even if it is the laminating mold photovoltaic cell which used said pin structure as the unit cell, and carried out two or more laminatings of this unit cell.

0059] <Gestalt 2 of operation> drawing 5 is the mimetic diagram of the plasma-CVD equipment concerning the gestalt 2 of operation of this invention. 31 in drawing is the substrate electrode formed in the shape of a roll, it rolls round before membrane formation initiation and it is rolled round by the roll 81. When the end of the substrate electrode 31 currently rolled round by this rolling-up roll 81 is rolled round and installation and this rolling-up roll 82 carry out evolution actuation at a roll 82, the substrate electrode 31 is rolled round from the rolling-up roll 81, moves to a roll 82 continuously and is rolled round by the rolling-up roll 82.

0060] Counter the whole surface of the substrate electrode 31, and the tabular cathode electrode 41 is arranged, and the opposed face to said whole surface of this cathode electrode 41 It inclines gently so that it may roll round from the end

by the side of the rolling-up roll 81 and the inter-electrode distance between this cathode electrode 41 and the substrate electrode 31 may become small first to the other end by the side of a roll 82. Subsequently As it inclines gently, it is formed so that it may incline rapidly so that it may become a plane so that uniformly [it may incline rapidly so that said inter-electrode distance may become large, next / said inter-electrode distance], and said inter-electrode distance may subsequently become small, and said inter-electrode distance may become large at the last. In addition, the same sign is given to the same part as the gestalt 1 of operation, and those explanation is omitted.

[0061] Since flow rate of material gas can be controlled and the presentation ratio of a film ingredient cannot be changed, when forming membranes to the substrate which moves, When the silicon germanium film from which the presentation ratio of the direction of thickness changes continuously is formed, The material gas (a silane and germane) of silicon germanium is supplied all over a reaction chamber 1 using a supply pipe 7. High-frequency voltage is impressed between the substrate electrode 31 and the cathode electrode 41, the plasma of material gas is generated between the substrate electrode 31 and the cathode electrode 41, and the substrate electrode 31 is made to move the inside of said plasma to it using RF generator 6.

[0062] A silane and germane do plasma decomposition, a silicon precursor and a germanium precursor arise, and compared with a silicon precursor, concentration becomes low as concentration is high at about 41 cathode electrode and it separates from this cathode electrode 41, and a layer with this equal concentration produces the germanium precursor with a small diffusion rate in accordance with the configuration of the opposed face of the cathode electrode 41. For this reason, the substrate electrode 31 passes in order two or more layers from which the concentration of each precursor differs, respectively. Pass a layer with the concentration of a germanium precursor high when the inter-electrode distance between the substrate electrode 31 and the cathode electrode 41 is small, and the amount of vacuum evaporation of a germanium precursor increases. Since a layer with said low concentration is passed and said amount of vacuum evaporation decreases when inter-electrode distance is large, the presentation ratio of the direction of thickness can form the silicon germanium film which changes continuously.

[0063] In addition, although the plasma-CVD equipment of the gestalt 2 of operation is the single chamber structure equipped only with the reaction chamber 1, you may be the structure equipped with two or more membrane formation rooms. Moreover, when an insulator is used as a substrate, you may make it prepare an electrode behind a substrate separately. Moreover, in the case of the substrate electrode which is not a roll-like, membranes may be formed like the gestalt of this operation using plasma-CVD equipment equipped with a means to move this substrate electrode. In addition, this invention is used in order to change it while forming the presentation ratio of two or more kinds of matter, and the same effectiveness can be acquired even if it is the case where for example, not only the silicon germanium film but the silicon carbon film is formed. Moreover, this invention may be used when forming the semi-conductor layer of a superstructure.

[0064] moreover, in having the 2nd electrode which has two or more slant faces which incline in the migration direction of the 1st electrode used as a substrate When the plasma-CVD equipment for forming the film to which the presentation ratio of the direction of thickness was changed continuously is manufactured, The 1st electrode used as a substrate moving, therefore controlling the flow rate of material gas, and changing a presentation ratio to difficult conventional plasma-CVD equipment It replaces with the 2nd conventional plate-like electrode, and manufacture can offer the good plasma-CVD equipment of a controllability easily, without having a complicated control means, in order to have the 2nd electrode which has two or more slant faces which incline in the migration direction of the 1st electrode in the side which counters said 1st electrode.

[0065] moreover, in using the 2nd electrode which has two or more slant faces which incline in the migration direction of the 1st electrode used as a substrate The 1st electrode used as the substrate which should form the film is arranged in a reaction chamber, and the material gas of the film ingredient which comes to use two or more matter is supplied all over said reaction chamber. Said 1st electrode, An electrical potential difference is impressed between the 2nd electrode which has two or more slant faces which incline in the migration direction of this 1st electrode in the side which counters said 1st electrode, and, subsequently to the direction of a flat surface of this 1st electrode, the 1st electrode is moved to it. At this time, material gas carries out plasma decomposition, said matter serves as a precursor, respectively, and concentration becomes low as concentration is high and it separates from this 2nd electrode near the 2nd electrode compared with a precursor with a large diffusion rate, and a layer with this equal concentration produces the precursor with a small diffusion rate along said slant face of the 2nd electrode. For this reason, the 1st electrode passes in order two or more layers from which the concentration of each precursor differs, respectively. Since pass a layer with the high concentration of said precursor, the amount of vacuum evaporation of this precursor increases, a layer with said concentration low when inter-electrode distance is large is passed and said amount of vacuum evaporation decreases, when the inter-electrode distance between this 1st electrode and the 2nd electrode is small, For example, the same

effectiveness as the membrane formation approach according to claim 4 can be acquired using plasma-CVD equipment according to claim 3.

[0066] Moreover, by using a silane and germane as material gas, concentration becomes low as the germanium precursor with a small diffusion rate with larger mass than a silicon precursor has the high concentration in a gaseous phase and separates from this 2nd electrode near the 2nd electrode compared with a silicon precursor. For this reason, since inter-electrode distance between the 1st electrode and the 2nd electrode is made small, the amount of vacuum evaporation of a germanium precursor can be increased, said inter-electrode distance can be enlarged and said amount of vacuum evaporation can be decreased, using plasma-CVD equipment given in any [claim 1 thru/or] of 3 they are, the silicon germanium film can be formed and the presentation ratio of this silicon germanium film can be changed to a precision.

[0067] Moreover, by setting the pressure in a reaction chamber to 100Pa or more, and setting inter-electrode distance between the 1st electrode and the 2nd electrode to 1.5cm or less, when a silane and germane are used as material gas since the plasma of high density carries out localization to the shape of a sheet from the 2nd electrode to a less than 1.5cm field and the rate of germane's precursor to the precursor of a silane becomes larger than germane's rate to the silane in material gas in this field from other parts, By moving the 2nd electrode, and bringing the 1st electrode close until it touches said field, this invention does the outstanding effectiveness so -- the utilization effectiveness of germane more expensive than a silane can be improved.

[0068] <Gestalt 3 of operation> drawing 7 is the mimetic diagram of the sputtering system concerning the gestalt 3 of operation of this invention. About the same part as drawing 1, the same sign is attached and detailed explanation is omitted. The reaction chamber 1 has carried out evacuation of the interior suitably using the exhaust air system 2, and discharge gas is suitably introduced through a supply pipe 7 and control-of-flow system 7a. Into the reaction chamber 1, opposite arrangement of the target electrode 10 and the substrate electrode 12 of a plane [opposed face] is carried out, respectively. RF generator 6 for discharge is connected to a target electrode 10, and the substrate electrode 12 is grounded. In addition, the potential of each electrode is suitably set up so that the plasma field 13 may be generated between a target electrode 10 and the substrate electrode 12. The substrate 5 which is the object of the membrane formation to the field which counters a target electrode 10, for example, a glass substrate, is arranged at the substrate electrode 12. The target 11 used as the raw material of membrane formation, for example, a metallic-oxide ingredient etc., counters a substrate 5, and it is arranged at a target electrode 10. The ion from the plasma field 13 collides with a target 11, and produces a spatter phenomenon, and the film of the predetermined ingredient according to a target 11 is formed by the substrate 5.

[0069] An actuator 8 and a control section 9 operate like the case of the gestalt 1 (drawing 1) of operation, and move a target electrode 10 in the attachment-and-detachment direction over the substrate electrode 12. That is, an actuator 8 is a lifting device which drives rise and fall of a target electrode 10, and a control section 9 is a rise-and-fall control unit which controls a lifting device. A control section 9 memorizes the modification data of the inter-electrode distance between the target electrode 10 from membrane formation initiation to membrane formation termination, and the substrate electrode 12 (only henceforth inter-electrode distance), and controls an actuator 8 suitably according to the memorized data. The memorized data are data of inter-electrode distance when the time amount and this time amount from membrane formation initiation pass, investigate beforehand time amount required since the film which has the relation and this presentation ratio of inter-electrode distance and the presentation ratio of the film ingredient when forming membranes in this inter-electrode distance under necessary membrane formation conditions is formed on a substrate 5, and decide on it. In addition, as long as modification to arbitration is possible for an actuator 8 and a control section 9 while inter-electrode distance forms membranes, they may be what kind of structure. As an RF spatter (RF sputtering system), although explained, it does not restrict to this and the application to DC spatter, an ECR spatter, the helicon wave plasma spatter method, etc. is also possible.

[0070] The membrane formation approach using the sputtering system concerning the gestalt 3 of operation is explained. For example, if inter-electrode distance is changed using a metallic oxide as an ingredient of a target 11, the presentation ratio of the target component element in the film formed on a substrate 5 can be controlled, and membranous physical properties (for example, conductivity) can be changed. That is, a membranous presentation ratio can be controlled by control of inter-electrode distance, and the film can be used as an insulator (oxide), a semi-conductor, or a conductor (metal). Moreover, it combines and the conductivity of a semi-conductor and a conductor can also be controlled to a precision. Specifically, the oxygen of the metallic oxide of a target 11 controls the amount which reaches a substrate 5 by controlling inter-electrode distance. Since an insulator (oxide) can be formed since oxygen reaches a substrate 5 enough, and oxygen cannot reach a substrate 5 when inter-electrode distance is long when inter-electrode distance is short, a conductor (metal) can be formed, and when inter-electrode distance is medium, the semi-conductor which is the middle conductivity of an insulator and a conductor can be formed.

0071] A table 5 is K (potassium) dope SrCu₂O_x in a SrCu (strontium copper) system oxide and a concrete target as a target 11. It uses and the membrane formation conditions at the time of changing inter-electrode distance and forming membranes on a substrate 5 are shown. The thickness of the formed film is 100nm. In addition, that what is necessary is just to fix the quantity of gas flow, precise control is completely unnecessary and serves as a good sputtering system of controllability, and the spatter approach. This effectiveness is the same about the gestalt 4 of operation or subsequent ones.

0072]

A table 5]

表 5

形成方法	RFマグネトロンスパッタ法
ターゲット	KドーパSrCu ₂ O _x ターゲット
基板温度 (℃)	600
反応圧力 (Pa)	2
アルゴン流量 (sccm)	5
酸素流量 (sccm)	30
RFパワー (W)	30
基板-ターゲット間距離 (cm)	1~10

0073] A table 6 shows the membrane formation conditions ZnO (zinc oxide) and at the time of changing inter-electrode distance, specifically using the non dope ZnO, and forming membranes on a substrate 5 as a target 11. The thickness of the formed film is 200nm.

0074]

A table 6]

表 6

形成方法	RFマグネトロンスパッタ法
ターゲット	ノンドーパZnOターゲット
基板温度 (℃)	700
反応圧力 (Pa)	15
アルゴン流量 (sccm)	30
RFパワー (W)	150
基板-ターゲット間距離 (cm)	1~10

0075] Drawing 8 is a graph which shows the distance dependency between substrate targets of the conductivity of the SrCu system oxide thin film which formed membranes according to the membrane formation conditions of a table 5 and a table 6, and a ZnO thin film. In a graph, an axis of abscissa shows "the distance between substrate-targets" (distance between substrate targets), and an axis of ordinate shows "conductivity." In addition, in the graduation of conductivity, 1.00E+02 mean 1x10². Also in any of a SrCu system oxide thin film and a ZnO thin film, the film with the large conductivity of an insulator to a metal is formed so that clearly from drawing. A reason is that activity oxygen will stop being able to reach even a substrate 5 easily, oxidation will stop being able to happen easily, and the ingredient near a metal presentation will be formed to not only a metal atom but an activity oxygen atom reaching a substrate 5 if the distance between substrate targets (inter-electrode distance) is short, a metal atom oxidizing, and an insulator being formed if the distance between substrate targets (inter-electrode distance) is long as mentioned above.

0076] Drawing 9 is structural drawing showing the cross-section structure of the semiconductor device created with the sputtering system concerning the gestalt 3 of operation. This drawing (a) is the semiconductor device (pn junction device) of the example concerning this invention, and (b) is the semiconductor device (pn junction device) created by the conventional approach shown for reference. In this drawing (a), it forms on the glass (glass) substrate 14 according to the conditions which show the ZnO film 15 of 600nm of thickness in a table 6. Under the present circumstances, it forms in ZnO semi-conductor thin film 15S continuously from ZnO metal membrane 15M, without changing the distance between substrate targets continuously from 10cm to 4cm, and exposing it to the open air with a single sputtering system without taking out to the exterior of a sputtering system). Since ZnO semi-conductor thin film 15S become a n-type semiconductor, ZnO metal membrane 15M are equivalent to n terminal electrode. It forms after ZnO semi-conductor thin

film 15S formation according to the conditions which show the SrCu system oxide thin film 16 of 200nm of thickness in table 5. Under the present circumstances, it forms in SrCu system oxide metal thin film 16M continuously from SrCu system oxide-semiconductor thin film 16S, without changing the distance between substrate targets continuously from 1cm to 10cm, and exposing it to the open air with a single sputtering system (without taking out to the exterior of a sputtering system). Since SrCu system oxide-semiconductor thin film 16S become a p type semiconductor, the SrCu system oxide metal thin film 16 is equivalent to p terminal electrode.

[0077] In this drawing (b), on a glass substrate 14, the ITO (indium tin oxide) film 17 of 300nm of thickness is formed, next the n-ZnO (n mold ZnO) film 18 of 400nm of thickness is formed by the conventional spatter. The ZnO membrane formation conditions in this case are conditions of a table 6, and when the distance between substrate targets is fixed with 1cm, they correspond. The p-SrCu (p mold SrCu) system oxide film 19 of 150nm of thickness is formed further after this. The membrane formation conditions of the SrCu system oxide in this case are conditions of a table 5, and when the distance between substrate targets is fixed with 6cm, they correspond. The aluminum (aluminum) film 20 of 30nm of thickness is formed with vacuum deposition on the p-SrCu system oxide film 19. The ITO film 17 is equivalent to n terminal electrode, and the aluminum film 20 is equivalent to p terminal electrode.

[0078] Drawing 10 is property drawing showing the property of the semiconductor device in drawing 9. It is current I (mA) to which an axis of abscissa flows to applied-voltage [to junction] V (V) among drawing, and an axis of ordinate flows to junction. Curve A is the semiconductor device (pn junction device) of the example concerning this invention, and Curve B is the semiconductor device (pn junction device) created by the conventional approach. The semiconductor device concerning this invention has small series resistance, and the good rectifying characteristic is acquired as compared with the semiconductor device created by the conventional approach. This difference is so remarkable that a current becomes large. That series resistance of the semiconductor device concerning this invention is made small In the ZnO thin film 15, a connection can be continuously formed in the semi-conductor film (ZnO semi-conductor thin film 15S) from a metal membrane (ZnO metal thin film 15M), In the SrCu system oxide thin film 16, from the ability of a connection to be continuously formed in a metal membrane (SrCu system oxide metal thin film 16M) from the semi-conductor film (SrCu system oxide-semiconductor thin film 16S) Contact resistance in each connection can be made small, and since the so-called contact property improved, it thinks.

[0079] Moreover, it sets to the semiconductor device created by the conventional approach. An ITO film 17 formation process, an n mold ZnO film 18 formation process, a p mold SrCu system oxide film 19 formation process, Four processes of an aluminum film 20 formation process are required, to needing a manufacturing installation different moreover, in the semiconductor device of the example concerning this invention, two processes of a ZnO thin film 15 formation process and a SrCu system oxide thin film 16 formation process are sufficient, and a manufacturing cost can decrease substantially.

[0080] In addition, as a target, there is no need of restricting to ZnO and SrCu system oxide, and it can be similarly applied to other oxide, for example, oxidization copper, ferrous oxide, titanium oxide, etc. Moreover, it does not restrict to a pn junction device as a device, and can apply to other semiconductor devices, for example, a thin film transistor, an EL element, a solar battery, etc. similarly. Moreover, control of the continuous conductivity of an insulator to a semiconductor enables it to realize the device of unprecedented new structure. For example, in a thin film transistor, formation of a new gate electrode with a continuous physical-properties (conductivity) change of an insulator to a semiconductor etc. is attained.

[0081] The sputtering system concerning the gestalt 3 of operation is used for the membrane formation approach concerning the gestalt 4 of the <gestalt 4 of operation> operation. For example, if inter-electrode distance is changed using the matter which contains two or more elements as an ingredient of a target 11, the presentation ratio of the target component element in the film formed on a substrate 5 is controllable. Generally from the energy of the element emitted to a gaseous phase from a target 11 being determined by ion collision, the rate of an element with big mass becomes slow. That is, to the substrate 5 of a long distance [element / heavier], it is hard to reach, and the presentation ratio in the formed film becomes small to it. Therefore, if this phenomenon is used, the presentation ratio of the element in the film formed by controlling inter-electrode distance is controllable using the target 11 containing two or more elements. According to this approach, in formation of the compound system thin film containing two or more elements, such as SiGe (silicon germanium), an alloy system thin film, etc., a presentation ratio is controllable to a precision.

[0082] A table 7 shows the membrane formation conditions at the time of changing inter-electrode distance and forming membranes on a substrate 5, using SiGe as a target 11. The thickness of the formed film is 200nm.

[0083]

[A table 7]

表 7

電極間距離 (mm)	20~150
基板温度 (℃)	200
圧力 (Pa)	1.5
RFパワー (W)	100
ターゲット材料	SiGe
ターゲットサイズ (インチφ)	5
アルゴン流量 (sccm)	10

[0084] Drawing 11 is a graph which shows the relation of the presentation ratio and inter-electrode distance in the direction of thickness of the SiGe thin film which formed membranes according to the membrane formation conditions of a table 7. The inter-electrode distance (mm) at the result of having measured distribution of the presentation ratio (%) of germanium to Si by SIMS about the case where changed the amorphous SiGe thin film and inter-electrode distance (distance of a substrate 5 and a target 11) is formed on the glass substrate 5, and the time of the thickness (depth location) formation corresponding to a SIMS measure point is shown. Moreover, although it will become a different numeric value from inter-electrode distance and a presentation ratio if it does not pass over the numeric value in drawing in the example but membrane formation conditions etc. are changed, there is no change in a presentation ratio being controllable to accuracy by changing inter-electrode distance. In addition, in the conventional sputter, in order to change a presentation ratio in the film to form, it is impossible to change a presentation ratio continuously in the thin film as changed the presentation ratio of a target 11 and shown in drawing.

[0085] <The gestalt 5 of operation> [0086] In the membrane formation approach concerning the gestalt 5 of operation, the sputtering system applied, for example to the gestalt 3 of operation is used. For example, if inter-electrode distance is changed when forming membranes using the thing containing the element which has the property which serves as a gas in the inside of two or more of these elements including two or more elements as an ingredient of a target 11, in the film formed on a substrate 5, the presentation ratio of an element which has a property used as a gas is controllable. Generally, it is tended to carry out localization of the plasma (plasma field 13 reference) by glow discharge near a target electrode 10. In this case, if the element which has a property used as a gas when the film containing two or more elements containing the element which has a property used as a gas is formed by the sputter separates from the plasma which carries out localization, it will be gasified, and it becomes that it is hard to be incorporated in the film to form. Therefore, if this phenomenon is used, the presentation ratio of the element in the film formed by controlling inter-electrode distance using the target 11 of the ingredient containing the element which has a property used as a gas to the inside of two or more elements is controllable. According to this approach, in formation of the metallic-oxide thin film containing the element which has the property which serves as a gas among base, a nitride thin film, etc., a presentation ratio is controllable to a precision.

[0087] A table 8 shows the membrane formation conditions at the time of changing inter-electrode distance and forming membranes on a substrate 5, using ZnO as a target 11. The thickness of the formed film is 200nm.

[0088]

A table 8]

表 8

電極間距離 (mm)	20~150
基板温度 (℃)	300
圧力 (Pa)	1.5
RFパワー (W)	100
ターゲット材料	ZnO
ターゲットサイズ (インチφ)	5
アルゴン流量 (sccm)	10
酸素流量 (sccm)	5

[0089] Drawing 12 is a graph which shows the relation of the presentation ratio and inter-electrode distance in the direction of thickness of the ZnO thin film which formed membranes according to the membrane formation conditions of a table 8. The inter-electrode distance (mm) at the result of having measured distribution of the presentation ratio (%) of O to Zn by SIMS about the case where changed the ZnO thin film and inter-electrode distance (distance of a substrate 5

and a target 11) is formed on the glass substrate 5, and the time of the thickness (depth location) formation corresponding to a SIMS measure point is shown. Moreover, although it will become a different numeric value from inter-electrode distance and a presentation ratio if it does not pass over the numeric value in drawing in the example but membrane formation conditions etc. are changed, there is no change in a presentation ratio being controllable to accuracy by changing inter-electrode distance. In addition, in the conventional sputter, in order to change a presentation ratio in the film to form, it is impossible to change a presentation ratio continuously in the thin film as changed the presentation ratio of a target 11 and shown in drawing.

[0090] In the membrane formation approach concerning the gestalt 6 of the <gestalt 6 of operation> operation, the sputtering system applied, for example to the gestalt 3 of operation is used. The membrane formation approach of this invention performs valence-electron control (pn control) of an II-VI group semi-conductor thin film by changing inter-electrode distance (distance between substrate targets), when forming an II-VI group semi-conductor thin film using the gas which contains V group atom as discharge gas (sputtering gas). Since valence-electron control of a semi-conductor thin film can be performed by changing inter-electrode distance, the electronic devices (TFT, FET, etc.) of the transistor to which two or more pn junction can be formed in, for example, pn junction has not only one rectifying device (diode) but pnp or npn junction, and others can be created by repeating valence-electron control.

[0091] For example, a ZnO thin film is formed as an II-VI group semi-conductor thin film, using nitrogen oxide gas (NO, NO₂, N₂O, etc.) as gas containing V group atom. In this case, a p mold conductivity ZnO thin film can be controlled and formed in a precision by lengthening inter-electrode distance by forming an n mold conductivity ZnO thin film, and shortening inter-electrode distance. If inter-electrode distance is shortened, into the film which becomes easy to reach a substrate 5 and is formed in it, activity nitrogen and a nitrogen oxide radical will become easy to incorporate nitrogen, and will serve as p mold conductivity. If inter-electrode distance is lengthened, into the film which stops being able to reach a substrate 5 easily and is formed in it, activity nitrogen and a nitrogen oxide radical will stop being able to incorporate nitrogen easily, and will serve as n mold conductivity.

[0092] In addition, the example of concrete membrane formation conditions is as follows. ZnO made it as the non dope (99.99% of purity), and the substrate 5 was made glass. Membrane formation conditions were made into the substrate temperature of 300 degrees C, the pressure of 1Pa, and RF power density 10 W/cm, changed inter-electrode distance (distance of a substrate 5 and a target 11) among 2-10cm, and formed the ZnO thin film. The thickness of the formed film is 200nm. Moreover, the ZnO thin film of n mold conductivity can be easily formed by controlling the amount of oxygen defects (increment), or using the target ingredient which added the impurity which serves as aluminum (aluminum) and donors, such as Ga (gallium).

[0093] ZnO is used as a target 11, N₂O (dinitrogen oxide) is used for it as sputtering gas, and a table 9 shows the inter-electrode distance at the time of changing inter-electrode distance and forming membranes on a substrate 5, and the relation of a conductivity type and conductivity. As shown in this table, the conductivity of a ZnO thin film changes from p mold to n mold as inter-electrode distance becomes long, and it is changing from n mold to p mold as inter-electrode distance becomes short.

[0094]

A table 9]

表 9

電極間距離 (cm)	導電率 (S/cm)	導電型
2	5×10^1	p
3	4×10^0	p
5	8×10^0	n
7	4×10^1	n
10	7×10^1	n

[0095] Drawing 13 is property drawing showing the property of the semiconductor device (pn junction device) created by valence-electron control in a table 9. Among drawing, the electrical potential difference (V) which impresses an axis of abscissa to junction, and an axis of ordinate are currents (mA) which flow to junction, and show the good rectifying characteristic. In addition, inter-electrode distance was set to 2cm at the time of p mold ZnO thin film formation, and was set to 10cm at the time of n mold ZnO thin film formation. The outline of a production process is as follows. Glass with the transparence electric conduction film (substrate 5) has been arranged to the sputtering system, inter-electrode

distance was set as 2cm, and the p mold ZnO thin film was formed. Then, inter-electrode distance was changed and set as 10cm, set in a sputtering system, and the n mold ZnO thin film was formed continuously. Then, the metal electrode was formed. With the same sputtering system, since pn junction can be formed continuously, a throughput is made early substantially.

[0096] In the membrane formation approach concerning the gestalt 7 of the <gestalt 7 of operation> operation, the sputtering system applied, for example to the gestalt 3 of operation is used. The membrane formation approach of this invention controls the concentration in the film of the element contained in reactant gas by controlling inter-electrode distance, when it includes the element contained in discharge gas (sputtering gas) in reactant gas including reactant gas in the film formed by the spatter. Generally, it is tended to carry out localization of the plasma (plasma field 13 reference) by glow discharge near a target electrode 10. When forming the film by the spatter using the gas containing reactant gas, if it separates from the plasma which carried out localization, since it will join together again and will return to stable gas, as for the reactant gas decomposed in the plasma field 13, the film becomes is hard to be incorporated. Therefore, if this phenomenon is used, the concentration in the inside of the film of the element contained in reactant gas is controllable to a precision by changing inter-electrode distance using the same target and the same sputtering gas. By modification of inter-electrode distance, control of doping of the semi-conductor thin film to form, hydrogenation, etc. can be simplified.

[0097] A table 10 shows the membrane formation conditions at the time of changing inter-electrode distance and forming membranes on a substrate 5, using PH₃ (phosphine) as reactant gas. The thickness of the formed film is 200nm. The ratio of PH₃ to Ar is 1%.

[0098]

A table 10]

表 10

電極間距離 (mm)	20~150
基板温度 (℃)	300
圧力 (Pa)	1.5
RFパワー (W)	100
ターゲット材料	Si
ターゲットサイズ (インチφ)	5
アルゴン流量 (sccm)	10
PH ₃ 流量 (sccm)	0.1

[0099] Drawing 14 is a graph which shows the relation of the P (Lynn) concentration and inter-electrode distance in the direction of thickness of Si thin film which formed membranes according to the membrane formation conditions of a table 10. Applying this drawing (a) to this invention, (b) is a graph which shows the relation of the P concentration and the quantity-of-gas-flow ratio in the direction of thickness of Si thin film which formed membranes by control of the conventional quantity of gas flow shown as reference. This drawing (a) shows the inter-electrode distance (mm) at the result of having measured distribution of P concentration (at%) to Si by SIMS about the case where changed Si thin film and inter-electrode distance (distance of a substrate 5 and a target 11) is formed on the glass substrate 5, and the time of the thickness (depth location) formation corresponding to a SIMS measure point. Moreover, although it will become a different numeric value from inter-electrode distance and P concentration if it does not pass over the numeric value in drawing in the example but membrane formation conditions etc. are changed, there is no change in P concentration distribution being controllable to accuracy by changing inter-electrode distance. In addition, although it was n mold dope which used PH₃ in the example, p mold dope using B₂H₆ (diboron hexahydride) etc. is also possible. Moreover, as a semiconductor material, things other than Si are also applicable. Although this drawing (b) is changing distribution of P concentration (at%) in the film formed by changing the quantity-of-gas-flow ratio (%) of PH₃ to Ar, it cannot perform control with it, but is clear in a controllability being bad as compared with the membrane formation approach of this invention. [a blunt reaction and] [quick]

[0100] A table 11 shows the membrane formation conditions at the time of changing inter-electrode distance and forming membranes on a substrate 5, using hydrogen as reactant gas. The thickness of the formed film is 200nm. The ratio of the hydrogen (H₂) to Ar is 30%.

[0101]

A table 11]

表 11

電極間距離 (mm)	20~150
基板温度 (℃)	300
圧力 (Pa)	1.5
RFパワー (W)	100
ターゲット材料	ZnO
ターゲットサイズ (インチφ)	5
アルゴン流量 (sccm)	10
水素流量 (sccm)	3

0102] Drawing 15 is a graph which shows the relation of the hydrogen concentration and inter-electrode distance in the direction of thickness of the ZnO thin film which formed membranes according to the membrane formation conditions of table 11. Applying this drawing (a) to this invention, (b) is a graph which shows the relation of the hydrogen concentration and the quantity-of-gas-flow ratio in the direction of thickness of the ZnO thin film which formed membranes by control of the conventional quantity of gas flow shown as reference. This drawing (a) shows the inter-electrode distance (mm) at the result of having measured distribution of the hydrogen concentration (at%) to ZnO by SIMS about the case where changed the ZnO thin film and inter-electrode distance (distance of a substrate 5 and a target 1) is formed on the glass substrate 5, and the time of the thickness (depth location) formation corresponding to a SIMS measure point. Moreover, although it will become a different numeric value from inter-electrode distance and hydrogen concentration if it does not pass over the numeric value in drawing in the example but membrane formation conditions etc. are changed, there is no change in hydrogen concentration distribution being controllable to accuracy by changing inter-electrode distance. Although this drawing (b) is changing distribution of the hydrogen concentration (at%) in the film formed by changing the quantity-of-gas-flow ratio (%) of hydrogen (H₂) to Ar, it cannot perform control with it, but is clear in a controllability being bad. [a blunt reaction and] [quick]

0103] <Gestalt 8 of operation> drawing 16 is the mimetic diagram of the sputtering system concerning the gestalt 8 of operation of this invention. About the same part as drawing 1, drawing 5, and drawing 7, the same sign is attached and detailed explanation is omitted. In a reaction chamber 1, the substrate electrode 31 is formed in the shape of a roll, and is arranged. The substrate electrode 31 currently rolled round by the rolling-up roll 81 is rolled round from the rolling-up roll 81, moves to a roll 82 continuously and is rolled round by the rolling-up roll 82. The whole surface by which the substrate (graphic display abbreviation) of the substrate electrode 31 is arranged is countered, and the target electrode 10 which has two or more slant faces along the travelling direction of the substrate electrode 31 is arranged. In the travelling direction of the substrate electrode 31, the inter-electrode distance between the substrate electrodes 31 inclines gently so that it may change gradually, and the slant face of a target electrode 10 is formed so that the direction which narrows inter-electrode distance, and the direction made large may become by turns. In addition, the predetermined film according to inter-electrode distance is formed in the substrate which the target (graphic display abbreviation) suitably required for the field which counters the substrate electrode 31 of a target electrode 10 has been arranged, and has been arranged by the reaction of the plasma field 13 at the substrate electrode 1.

0104] You may make it change inter-electrode distance by changing the configuration of the substrate electrode 31. Although the reaction chamber 1 is used as the single chamber, it is also possible to consider as two or more reaction chambers. As long as the need of restricting in the shape of a roll is the approach of there not being, and forming membranes while moving, it may be what kind of thing. Migration can also be considered as the configuration which not the substrate electrode 31 but the target electrode 10 moves. According to this sputtering system, as compared with the sputtering system concerning the gestalt 3 of operation, mass production nature improves substantially. Moreover, also in the membrane formation approach concerning the gestalt 3 of operation thru/or 7, the sputtering system concerning the gestalt 8 of operation can be applied, and the volume efficiency in each membrane formation approach can be heightened further.

0105] <Gestalt 9 of operation> drawing 17 is the mimetic diagram of the sputtering system concerning the gestalt 9 of operation of this invention. About the same part as drawing 1, drawing 5, drawing 7, and drawing 16, the same sign is attached and detailed explanation is omitted. Two or more partial electrodes 10a and 10b which make the substrate electrode 31 and a parallel flat surface, and counter, and the target electrode 10 equipped with ... are arranged along the travelling direction of the substrate electrode 31. Two or more partial electrodes 10a and 10b are changing inter-electrode distance with the substrate electrode 31. This inter-electrode distance and the die length in the migration direction are suitably set up according to the description of the film to form etc. In addition, the predetermined film according to inter-

electrode distance is formed in the substrate which the target (graphic display abbreviation) suitably required for the field which counters the substrate electrode 31 of a target electrode 10 has been arranged, and has been arranged by the reaction of the plasma field 13 at the substrate electrode 1. In addition, it is possible to consider as the same configuration as the gestalt 8 of operation. According to this sputtering system, as compared with the sputtering system concerning the gestalt 3 of operation, mass production nature improves substantially like the gestalt 8 of operation.

Moreover, also in the membrane formation approach concerning the gestalt 3 of operation thru/or 7, the sputtering system concerning the gestalt 9 of operation can be applied, and the volume efficiency in each membrane formation approach can be heightened further.

[0106]

Effect of the Invention] Since it is considered as the configuration which carries out adjustable control of the distance between the part of the 1st electrode and the 2nd electrode which should arrange a substrate according to the membrane formation equipment of this invention, it becomes possible to be able to control the physical properties of the film to form easily, and to offer the good membrane formation equipment of the controllability with sufficient productivity which can form membranous.

[0107] According to the plasma-CVD equipment of this invention, the plasma-CVD equipment for forming the film to which the presentation ratio of the direction of thickness was changed continuously can be offered by having a means to change the inter-electrode distance between the 1st electrode and the 2nd electrode. To conventional plasma-CVD equipment equipped with the actuator which adjusts the inter-electrode distance between the 1st electrode which should arrange a substrate, and the 2nd electrode it is supposed that a means to control said actuator to change according to the situation of the film which forms the inter-electrode distance between the 1st electrode and the 2nd electrode according to the modification data of inter-electrode distance is added. Manufacture can offer the good plasma-CVD equipment of controllability easily, without having a complicated control means, since it is not necessary to design this means in consideration of the detailed flow of material gas.

[0108] Moreover, the plasma-CVD equipment for forming the film to which the presentation ratio of the direction of thickness was changed continuously can be offered by having the 2nd electrode which has two or more slant faces which incline in the migration direction of the 1st electrode or the 2nd electrode. At least one side moves among the 1st electrode which should arrange a substrate, or the 2nd electrode. To therefore, difficult conventional plasma-CVD equipment, controlling the flow rate of material gas and changing a presentation ratio in order to have the 2nd electrode which has two or more slant faces which replace with the 2nd conventional plate-like electrode, and incline in the migration direction of the 1st electrode or the 2nd electrode in the side which counters said 1st electrode, Manufacture can offer the good plasma-CVD equipment of a controllability easily, without having a complicated control means.

[0109] According to the membrane formation approach of this invention, by making the 2nd electrode approach or separate, the substrate which should form the film is arranged to the 1st electrode, the material gas (a silane and germane) of the film ingredient (for example, silicon germanium) which comes to use two or more matter is supplied all over a reaction chamber, and an electrical potential difference is impressed to the 1st electrode which arranges the substrate between the 1st electrode and the 2nd electrode. At this time, material gas carries out plasma decomposition, said matter serves as a precursor (a silicon precursor and germanium precursor), respectively, and when this precursor vapor-deposits to a substrate, the film (silicon germanium film) is formed in a substrate. The presentation ratio of the film ingredient deposited on the substrate is proportional to the ratio of concentration of the precursor with which this substrate touched. Concentration becomes low as the precursor with a small diffusion rate has the high concentration in a gaseous phase and separates from this 2nd electrode near the 2nd electrode compared with a precursor with a large diffusion rate. For this reason, inter-electrode distance between the 1st electrode and the 2nd electrode is made small during membrane formation, and the presentation ratio of a film ingredient can be changed to a precision, without changing other formation conditions, such as a flow rate of material gas, or discharge conditions, using plasma-CVD equipment according to claim 2, since a diffusion rate can increase the amount of vacuum evaporation of a small precursor, can enlarge said inter-electrode distance and can decrease said amount of vacuum evaporation.

[0110] Moreover, since said concentration falls more rapidly and regularly as it comes to carry out localization of the plasma to the 2nd electrode side extremely and separates from this 2nd electrode the more, the more the pressure in a reaction chamber is high, when the plasma is being generated in a reaction chamber, the presentation ratio of a film ingredient can be changed more to a precision. Moreover, near the 2nd electrode, since the concentration of a precursor with a small diffusion rate becomes high, the ratio of concentration of a precursor becomes larger than the flow rate of material gas, the alimention of a film ingredient with the small diffusion rate of a precursor increases, and the utilization effectiveness of this film ingredient improves.

[0111] Moreover, by using the 2nd electrode which has two or more slant faces which incline in the migration direction

of the 1st electrode or the 2nd electrode The substrate which should form the film is arranged to the 1st electrode, the material gas of the film ingredient which comes to use two or more matter is supplied all over a reaction chamber, and an electrical potential difference is impressed between said 1st electrode and the 2nd electrode which has two or more slant faces. Subsequently At least one side is moved in the direction of a flat surface of the 1st electrode among the 1st electrode or the 2nd electrode. At this time, material gas carries out plasma decomposition, said matter serves as a precursor, respectively, and concentration becomes low as concentration is high and it separates from this 2nd electrode near the 2nd electrode compared with a precursor with a large diffusion rate, and a layer with this equal concentration produces the precursor with a small diffusion rate along said slant face of the 2nd electrode. For this reason, the 1st electrode will pass in order two or more layers from which the concentration of each precursor differs, respectively. Since pass a layer with the high concentration of said precursor, the amount of vacuum evaporation of this precursor increases, a layer with said concentration low when inter-electrode distance is large is passed and said amount of vacuum evaporation decreases, when the inter-electrode distance between this 1st electrode and the 2nd electrode is small, For example, the same effectiveness as the membrane formation approach according to claim 4 can be acquired using plasma-CVD equipment according to claim 3.

[0112] Since [according to the membrane formation approach using the sputtering system and this sputtering system of his invention] it has a means to change the inter-electrode distance between the 1st electrode and the 2nd electrode physical properties (a conductor --) which are different in a single sputtering system, a single target, and a single process The sputtering system which can form film, such as classification of a semi-conductor and an insulator, a presentation, a presentation ratio, a conduction type, and conductivity, in arbitration, And when the membrane formation approach can be offered, for example, an oxide ingredient is used for a target, the sputtering system which can make a membranous class with a conductor, a semi-conductor, and an insulator, and can divide it, and the membrane formation approach can be offered.

[0113] Since [according to the membrane formation approach using the sputtering system and this sputtering system of his invention] it has the 2nd electrode which has two or more slant faces which incline in the migration direction of the 1st electrode or the 2nd electrode physical properties (a conductor --) which are different in a single sputtering system, a single target, and a single process The sputtering system excellent in the mass production nature which can form film, such as classification of a semi-conductor and an insulator, a presentation, a presentation ratio, a conduction type, and conductivity, in arbitration, And when the membrane formation approach can be offered, for example, an oxide ingredient is used for a target, the sputtering system which can make a membranous class with a conductor, a semi-conductor, and an insulator, and can divide it, and the membrane formation approach can be offered.

[0114] Since [according to the membrane formation approach using the sputtering system and this sputtering system of his invention] it has the 2nd electrode which has two or more partial electrodes with which the distance between the 1st electrode differs physical properties (a conductor --) which are different in a single sputtering system, a single target, and a single process The sputtering system excellent in the mass production nature which can form film, such as classification of a semi-conductor and an insulator, a presentation, a presentation ratio, a conduction type, and conductivity, in arbitration, And when the membrane formation approach can be offered, for example, an oxide ingredient is used for a target, the sputtering system which can make a membranous class with a conductor, a semi-conductor, and an insulator, and can divide it, and the membrane formation approach can be offered.

[0115] According to the membrane formation approach using the sputtering system and this sputtering system of this invention, in formation of the metallic-oxide thin film containing the element which has the property which serves as a gas among base, for example, a nitride thin film, etc., the sputtering system which can control a presentation ratio to a precision, and the membrane formation approach can be offered. Moreover, it faces, forming an II-VI group semi-conductor thin film for example, and the sputtering system which can make an II-VI group semi-conductor thin film with a mold and a mold at the time of formation, and can divide a membranous class, and the membrane formation approach can be offered by controlling inter-electrode distance by forming the film by which valence-electron control was carried out in the direction of thickness. Moreover, the sputtering system which can control the concentration in the film of the element contained in reactant gas, for example, and the membrane formation approach can be offered.

[0116] It faces carrying out modification control of the physical properties of the film to form according to the membrane formation approach using the sputtering system and this sputtering system of this invention, since membranes can be formed without taking out the substrate with which the film is formed to the exterior of a sputtering system, simplification of a device creation process is attained and a throughput becomes early, as a result it becomes improvable reduction of a manufacturing cost, and a property]. Moreover, since control of the film is made to arbitration, efficient formation of creation of a new structure device, a modulation dope ingredient, a multilayer, and energy gap modulation amorphous materials is attained. Furthermore, precise control of a control-of-flow system is effective in becoming

completely unnecessary.

Translation done.]